Claims

What is claimed is:

1. An image projection system comprising:

a screen having a curved image-receiving surface, wherein the curved surface defines a radial center for the screen, and wherein the radial center of the screen is separated from the curved surface by a defined radius;

a projector for relaying images onto the screen, wherein the projector is positioned at a projection point which is located between the surface of the screen and the radial center of the screen; and

a lens coupled with the projector, wherein the lens is a fisheye-type lens;

wherein the image is produced from a source image which is mapped to correct for distortion created by parallax resulting from displacement of the projector from the radial center of the screen.

2. The system of claim 1 wherein the screen is substantially spherical in shape.

3. The system of claim 1 wherein the image is comprised of a plurality of pixels, and wherein forwardmost

pixels located toward the front of the screen are made smaller than rearwardmost pixels located toward the rear of the screen, thereby developing a higher resolution toward the front of the screen and a lower resolution toward the rear of the screen.

4. The system of claim 3 wherein a normalized displacement ratio (R) is given by a ratio of a displacement of the projector from the radial center of the screen (d_r) to the defined radius (r), wherein the size of the forwardmost pixels is scaled down by a factor (S_f), where $S_f = (r-d_r)/r$, and wherein the size of the rearwardmost pixels is scaled up by a factor (S_b), where $S_b = (r+d_r)/r$.

5. The system of claim 4 wherein a front-to-back resolution ratio (F) is given by the ratio $F = S_b/S_f$, and wherein the front-to-back resolution ratio (F) is between 1.5 and 6.

6. The system of claim 1 wherein the image has a forwardmost brightness for portions of the image toward the front of the screen which is brighter than a rearwardmost brightness for portions of the image toward the rear of the screen.

7. The system of claim 6 wherein a higher contrast is developed toward the front of the screen and a lower contrast is developed toward the rear of the screen.

8. The system of claim 6 which further includes a brightness compensation mask applied to the source image.

9. The system of claim 8 wherein the brightness compensation mask is optically applied to the source image.

10. The system of claim 8 wherein the brightness compensation mask is electronically applied to the source image.

11. The system of claim 1 wherein a critical field-of-view is measured at an equator of the curved surface of the screen, with respect to a point at the radial center of the screen, within which an actual pixel resolution and an actual image brightness both exceed a resolution and a brightness produced by a projection from the radial center of the screen, and outside of which resolution and brightness drop below the resolution and the brightness produced by the projection from the radial center of the screen, wherein the critical field-of-view is given by the equation $2\cos^{-1}(R/2)$, where (R) is a normalized displacement ratio given by a ratio of a displacement of the projector from the radial center of the screen to the defined radius.

12. The system of claim 11 wherein the critical field-of-view substantially matches an average viewer's primary visual field, and an area lying outside the critical

field-of-view substantially matches the average viewer's peripheral visual field.

13. The system of claim 1 which further includes seating coupled with the screen, wherein the seating is grouped in plural rows, and wherein the projector is located at or between a first row of the seating nearest to the surface of the screen and the surface of the screen.

14. The system of claim 1 having only a single projector.

15. The system of claim 14 wherein the projector is a video projector.

16. The system of claim 14 wherein the projector is a film projector.

17. The system of claim 1 which further includes a digital image processor for mapping the source image to correct for the distortion.

18. The system of claim 17 which further includes a three-dimensional eyepoint projection of the source image to correct for the distortion.

19. A method for projecting a series of images onto a screen having a curved image-receiving surface, wherein the curved surface defines a radial center for the screen, wherein the radial center of the screen is separated from the curved surface by a defined radius, and wherein the method comprises the steps of:

positioning a projector for relaying the series of images onto the screen at a projection point which is located between the surface of the screen and the radial center of the screen;

projecting the series of images onto the screen using a lens coupled with the projector, wherein the lens is a fisheye-type lens; and

producing the series of images from source images which are mapped to correct for distortion created by parallax resulting from displacement of the projector from the radial center of the screen.

20. The method of claim 19 wherein the screen is substantially spherical in shape.

21. The method of claim 19 wherein each of the series of images is comprised of a plurality of pixels, and which further includes the step of making forwardmost pixels located toward the front of the screen smaller than rearwardmost pixels located toward the rear of the screen, developing a higher

resolution toward the front of the screen and developing a lower resolution toward the rear of the screen.

22. The method of claim 21 wherein a normalized displacement ratio (R) is given by a ratio of a displacement of the projector from the radial center of the screen (d_r) to the defined radius (r), and which further includes the step of scaling down the size of the forwardmost pixels by a factor (S_f), where $S_f = (r-d_r)/r$, and scaling up the size of the rearwardmost pixels by a factor (S_b), where $S_b = (r+d_r)/r$.

23. The method of claim 22 wherein a front-to-back resolution ratio (F) is given by the ratio $F = S_b/S_f$, and which further includes the step of setting the front-to-back resolution ratio (F) between 1.5 and 6.

24. The method of claim 19 which further includes the step of developing a forwardmost brightness for portions of the images toward the front of the screen which is brighter than a rearwardmost brightness for portions of the images toward the rear of the screen.

25. The method of claim 24 which further includes the step of developing a higher contrast toward the front of the screen and a lower contrast toward the rear of the screen.

26. The method of claim 24 which further includes the step of applying a brightness compensation mask to the source images.

27. The method of claim 26 which further includes the step of gradually attenuating the brightness for portions of the images toward the front of the screen using the brightness compensation mask.

28. The method of claim 26 which further includes the step of optically applying the brightness compensation mask to the source images.

29. The method of claim 26 which further includes the step of electronically applying the brightness compensation mask to the source images.

30. The method of claim 19 which further includes the step of measuring a critical field-of-view at an equator of the curved surface of the screen, with respect to a point at the radial center of the screen, within which an actual pixel resolution and an actual image brightness both exceed a resolution and a brightness produced by a projection from the radial center of the screen, and outside of which resolution and brightness drop below the resolution and the brightness produced by the projection from the radial center of the screen, wherein

the critical field-of-view is given by the equation $2\cos^{-1}(R/2)$, where (R) is a normalized displacement ratio given by a ratio of a displacement of the projector from the radial center of the screen to the defined radius.

31. The method of claim 30 which further includes the step of selecting the critical field-of-view by adjusting the displacement ratio (R) so that the critical field-of-view substantially matches an average viewer's primary visual field, and an area lying outside the critical field-of-view substantially matches the average viewer's peripheral visual field.

32. The method of claim 19 wherein seating is coupled with the screen, wherein the seating is grouped in plural rows, and wherein the method further includes the step of locating the projector at or between a first row of the seating nearest to the surface of the screen and the surface of the screen.

33. The method of claim 19 which further includes the step of providing only a single projector for relaying images onto the screen.

34. The method of claim 33 wherein the projector projects video images onto the screen.

35. The method of claim 33 wherein the projector projects film images onto the screen.

36. The method of claim 19 which further includes the step of re-mapping the source images to correct for the distortion.

37. The method of claim 36 which further includes the step of re-mapping the source images to achieve a substantially spherical image.

38. The method of claim 36 which further includes the step of performing a three-dimensional eyepoint projection of the source images to correct for the distortion.

39. The method of claim 38 which further includes the step of applying digital image processing to the source images.

40. The method of claim 39 which further includes the step of applying the digital image processing to the source images in real time.

41. The method of claim 39 which further includes the step of outputting the re-mapped source images to a digital video storage medium.

42. The method of claim 39 which further includes the step of scanning the re-mapped source images onto a film medium.

43. The method of claim 38 wherein the three-dimensional eyepoint projection of the source images includes the steps of:

mapping an original spherical image onto a virtual sphere;

geometrically projecting pixels on the virtual sphere onto a view sphere which is displaced by a ratio (R), where (R) is given by a ratio of a displacement of the projector from the radial center of the screen to the defined radius; and

preparing the view sphere which is displaced by the ratio (R) for fisheye projection.

44. The method of claim 43 wherein the preparing of the view sphere includes the step of performing a 2-dimensional, equidistant azimuthal or polar mapping.

45. The method of claim 38 wherein the three-dimensional eyepoint projection is performed as a two-dimensional image warping algorithm.